

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

COURSE DESCRIPTION

HVAC/R I is a course that will introduce students to basic skills and knowledge related to residential and commercial heating, ventilation, air conditioning, and refrigeration (HVAC/R). Topics covered include tools and equipment, safety, hazards unique to HVAC/R work, physics principles, mechanical refrigeration cycle, and installation and servicing of HVAC/R systems. Course content provides students with skill and knowledge to advance to *HVAC/R II*. Students Completing HVAC/R I will be eligible to take the Core, Type I and Type II technician certification of the EPA Proper Refrigerant Usage and Handling examination.

Prerequisite(s):	Construction Core
	Algebra I or Math for Technology II (may be concurrent)
Recommended Credits:	2
Recommended Grade Level(s):	10 th or 11 th

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I STANDARDS
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- 1.0 Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.
- 2.0 Students will evaluate career opportunities and career paths within the heating, ventilation, air conditioning, and refrigeration industry.
- 3.0 Students will demonstrate the principles of safety and health procedures in the heating, ventilation, air conditioning, and refrigeration industry.
- 4.0 Students will identify, select, use, maintain, and store tools, instruments, and equipment used in the heating, ventilation, air conditioning, and refrigeration industry.
- 5.0 Students will analyze and implement procedures to mitigate hazards associated with heating, ventilation, air conditioning, and refrigeration work.
- 6.0 Students will demonstrate proper refrigerant handling and usage as mandated by Environmental Protection Agency (EPA) Section 608 of the Clean Air Act.
- 7.0 Students will relate the principles of physics to the operation of heating, ventilation, air conditioning, and refrigeration systems.
- 8.0 Students will comprehend and explain the processes involved in the basic mechanical refrigeration cycle.
- 9.0 Students will comprehend, install, and service major components in mechanical refrigeration systems.
- 10.0 Students will assemble, charge, and service refrigerant systems.
- 11.0 Students will demonstrate proper use and application of various refrigerants and oils.
- 12.0 Students will communicate skills required in the heating, ventilation, air conditioning, and refrigeration industry.
- 13.0 Students will demonstrate interpersonal and employability skills required in the heating, ventilation, air conditioning, and refrigeration industry.

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 1.0

Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

LEARNING EXPECTATIONS

The student will:

- 1.1 Cultivate leadership skills.
- 1.2 Participate in SkillsUSA-VICA as an integral part of instruction.
- 1.3 Assess situations within the school, community, and workplace and apply values to develop and select solutions.
- 1.4 Demonstrate the ability to work cooperatively with others.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 1.1.A Takes initiative in meetings to actively influence the results of deliberations.
- 1.1.B Uses critical-thinking and consensus building skills in group deliberations.
- 1.2.A Applies high ethical standards to personal, community, and professional situations.
- 1.2.B Participates and conducts meetings according to accepted rules of parliamentary procedure.
- 1.3.A Analyzes simulated workplace situations and uses problem-solving and critical-thinking techniques to suggest solutions the problem.
- 1.3.B Analyzes socio-economic conflicts associated with the construction industry and apply values to evaluate possible ways to mitigate the conflicts.
- 1.4.A Participates in a committee.
- 1.4.B Contributes to a group project.

SAMPLE PERFORMANCE TASKS

- Create a leadership inventory and use it to conduct a personal assessment.
- Participate in various SkillsUSA-VICA or similar programs and/or competitive events.
- Evaluate a civic project within the school, community, and/or workplace and evaluate the expected long term effects of the project.
- Prepare a meeting agenda for a school or community meeting.
- Attend meetings of a related professional organization.
- Participate in a design team to complete an assigned project.

INTEGRATION LINKAGES

SkillsUSA-VICA, *Professional Development Program*, SkillsUSA-VICA, Communications and Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Math, Applied Communications, Algebra, Geometry, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, SCANS (Secretary's Commission on Achieving Necessary Skills), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency

(EPA), United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, (ASHRAE), Air Conditioning Contractors of America (ACCA), Refrigeration Service Engineers Society (RSES)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 2.0

Students will evaluate career opportunities and career paths within the heating, ventilation, air conditioning, and refrigeration industry.

LEARNING EXPECTATIONS

The student will:

- 2.1 Explain titles, roles, and functions of individuals in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.2 Investigate employment and entrepreneurial opportunities in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.3 Evaluate personal characteristics required for working in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.4 Investigate post secondary education, professional organizations, and trade publications appropriate for continuing education.

PERFORMANCE STANDARDS

The student:

- 2.1A Researches occupations within the heating, ventilation, air conditioning, and refrigeration industry.
- 2.1B Categorizes major responsibilities for each occupation in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.2 Researches and develops a projection of industry trends related to career opportunities in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.3 Profiles personal characteristics that are beneficial to the success of a professional in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.4.A Investigates career options and charts the characteristics of various careers in the heating, ventilation, air conditioning, and refrigeration industry.
- 2.4.B Researches and sets up and maintains a file outlining professional organizations, current issues, future trends, and emerging technologies in the HVAC/R industry.
- 2.4.C Researches and locates information on post secondary schools that offer HVAC/R training.

SAMPLE PERFORMANCE TASKS

- Categorize employment and entrepreneurial opportunities (listing salary).
- Develop a profile of career opportunities, education requirements, and projected future employment.
- Develop a personal career plan.
- Appraise professional heating, ventilation, air conditioning, and refrigeration industry organizations and explain their purposes.
- Incorporate professional terminology into conversation.
- Attend meetings of a related professional trade organization.

INTEGRATION LINKAGES

Art, Math, Math for Technology, Chemistry, Science, Health, Manipulative Skills, Communication Skills, Teamwork Skills, Language Arts, Research and Writing Skills, Decision Making Skills, Critical Thinking Skills, Secretary's Commission on Achieving Necessary Skills, (SCANS), Occupational Safety and Health Administration (OSHA), Environmental Protection Agency (EPA), Tennessee Occupational Safety and Health Administration (TOSHA), American Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, (ASHRAE), Air Conditioning Contractors of America (ACCA), Refrigeration Service Engineers Society (RSES)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 3.0

Students will demonstrate the principles of safety and health procedures in the heating, ventilation, air conditioning, and refrigeration industry.

LEARNING EXPECTATIONS:

The student will:

- 3.1 Implement safety procedures established by the Environmental Protection Agency (EPA) and Occupational Safety & Health Administration (OSHA).
- 3.2 Analyze and categorize safety and health hazards and their prevention and treatment in the heating, ventilation, air conditioning, and refrigeration industry.
- 3.3 Exhibit acceptable dress and personal grooming identified by the heating, ventilation, air conditioning, and refrigeration industry.
- 3.4 Demonstrate first aid practices.
- 3.5 Comprehend the importance of a safe work environment.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 3.1A Establishes and maintains a safe and healthy working environment.
- 3.1B Distinguishes and employs preventive measures of ecological, chemical, and physical contaminants.
- 3.1.C Interprets information from a Material Safety Data Sheet (MSDS).
- 3.1.D Passes a written test with 100% accuracy on HVAC/R regulations.
- 3.1.E Passes a performance test with 100% accuracy on tools, instruments, and equipment used in the HVAC/R industry.
- 3.1.F Maintains a portfolio recording safety written and performance tests achievements.
- 3.2.A Maintains heating, ventilation, air conditioning, and refrigeration equipment and laboratory in a safe and clean condition.
- 3.2.B Differentiates between hazardous materials, substances, and waste.
- 3.2.C Retrieves MSDSs and identifies the health hazards associated with new materials.
- 3.2.D Reports hazards found on the job site to their supervisor.
- 3.2.E Erects shields, barriers, and signage to protect coworkers and bystanders prior to starting potentially hazardous tasks.
- 3.2.F Provides and activates adequate ventilation equipment as required by the task.
- 3.3.A Compares and contrasts acceptable dress and personal grooming for specific jobs in the heating, ventilation, air conditioning, and refrigeration industry.
- 3.3.B Selects, inspects, and uses the correct personal protective equipment for the assigned task.
- 3.4 Administers simulated basic first aid procedures including treating burns and cuts and electrical shock.
- 3.5.A Researches the effects of substance abuse on performance.
- 3.5.B Inspects, maintains, and employs safe operating procedures with tools and equipment, such as hand and power tools, ladders, and lifting equipment.
- 3.5.C Continuously is aware of potential hazards to themselves and others.
- 3.5.D Comprehends their responsibilities under HazCom regulations.

- 3.5.E Comprehends their responsibilities, regulations, and company policies to protect coworkers and bystanders from hazards.
- 3.5.F Comprehends their responsibilities, regulations, and company policies regarding reporting of accidents and observed hazards, and regarding emergency response procedures.
- 3.5.G Operates and maintains tools in accordance with manufacturer's instructions and as required by regulation or company policy.

SAMPLE PERFORMANCE TASKS

- Conduct a safety and health inspection and identify any potential hazards.
- List causes of most common accidents and outlines a safety prevention program.
- Participate in the Occupational Health and Safety competitions with SkillsUSA-VICA.
- Outline a safety management program.
- Develop emergency policies for the HVAC/R laboratory.
- Role-play proper procedure for treating burns, cuts, electrical shock treatments according to standards set forth by the American Red Cross.
- Obtain an American Red Cross First Aid Certification and/or CPR Certification.
- Select, inspect, and use the correct personal protective equipment for the assigned task.
- Inspect power tools for intact guards, shields, insulation, and other protective devices.
- Inspect extension cords for the presence of a functional ground connection, prior to use.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Applied Communications, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency (EPA), United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES), American Red Cross

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 4.0

Students will identify, select, use, maintain, and store tools, instruments, and equipment used in the heating, ventilation, air conditioning, and refrigeration industry.

LEARNING EXPECTATIONS

The student will:

- 4.1 Illustrate the function and purpose of HVAC/R hand and power tools.
- 4.2 Select meters and instruments of the HVAC/R industry for a specific job.
- 4.3 Demonstrate the correct use, storage and care of HVAC/R equipment.
- 4.4 Properly maintain and store HVAC/R hand tools.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 4.1.A Differentiates between common HVAC/R hand and power tools.
- 4.1.B Selects the appropriate tool for a given task.
- 4.1.C Demonstrates safety procedures for the use of hand tools and instruments.
- 4.1.D Demonstrates how to use tools to perform maintenance, fabrication, or installation tasks.
- 4.2. Selects, demonstrates the correct use and storage of the following meter and instruments of the HVAC/R industry.

• Gauge manifold assembly	• Digital ammeter
• Sling psychrometer	• Tachometer
• Digital thermometer	• Electronic vacuum gauge
• Manometer	• Electronic scales
• Digital volt-Ohm meter	• Digital capacitor analyzer
• Electronic leak detector	• Velometer
• Gas pressure gauge	• Refractometer

- 4.3.A Selects, demonstrates the correct use and storage of equipment used in the HVAC/R industry.

• Acetylene torch	Refrigerant recovery machine
• Oxy-acetylene torch	Refrigerant recovery cylinder
• Vacuum pumps	Charging cylinder
• Schrader valve tool	Oil pump

- 4.3.B Develops and practices acceptable procedures for the use of shop equipment.
- 4.4 Follows proper use, care, and maintenance procedures for HVAC/R hand tools.

SAMPLE PERFORMANCE TASKS

- Use hand and power tools without damage to tools or fasteners.
- Set up, adjust, and operate acetylene and/or oxy-acetylene torch.
- Cut, clean, swage, flare, bend and fit tubing according to instructions.
- Test the efficiency of a vacuum pump using an electronic vacuum gauge.
- Set up a refrigerant recovery machine, gauge manifold assembly, recovery cylinder, and demonstrate the proper use.
- Remove control panel(s) and measure the voltage and current draw of an electric motor.

- Measure the resistance of a motor winding.
- Measure the capacitance of a run capacitor.
- Weigh a refrigerant cylinder and test for refrigerant leaks.
- Measure the relative humidity of a given conditioned space.
- Measure the air velocity of a given supply air duct.
- Measure the RPM of a condenser fan motor.
- Measure the manifold pressure of a given gas appliance.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Applied Communications, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency (EPA), United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 5.0

Students will analyze and implement procedures to mitigate hazards associated with heating, ventilation, air conditioning, and refrigeration work.

LEARNING EXPECTATIONS

The student will:

- 5.1 Evaluate and mitigate the potential risk of injury from electrical shock, burns, and moving parts for a given task.
- 5.2 Use and care for protective equipment for HVAC/R workers.
- 5.3 Follow procedures for maintaining a breathable atmosphere when working on HVAC/R systems where appropriate.
- 5.4 Handle oxygen, fuel, and inert gas cylinders according to industry practice and regulations.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 5.1.A Explains the potential risk of injury from electrical shock for a given task.
- 5.1.B Explains the potential risk of injury from burns for a given task.
- 5.1.C Explains the potential risk of injury from rotating fans, belts, and shafts for a given task.
- 5.1.D Uses appropriate lockout/tagout procedures when working on HVAC/R systems.
- 5.2 Selects, inspects, and uses the correct personal protective equipment, such as gloves, and head, eye, and face protection.
- 5.3.A Describes and demonstrates safety procedures to prevent carbon monoxide poisoning.
- 5.3.B Assesses the air supply and ventilation of combustion processes in HVAC/R equipment.
- 5.3.C Demonstrates knowledge of the hazardous nature of refrigerants other than CFC and HCFC, such as ammonia, sulfur dioxide, and carbon dioxide, as detailed in the appropriate MSDSs.
- 5.3.D Follows effective procedures for providing adequate ventilation when soldering, brazing, and flushing HVAC/R piping in constricted locations.
- 5.3.E Demonstrates safety practices, including Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) requirements for the HVAC/R industry.
- 5.4.A Stores oxygen and fuel gas cylinders in an upright and secured position.
- 5.4.B Operates with oxygen and fuel gas cylinders in an upright and secured position.
- 5.4.C Installs cylinder caps immediately upon removal of gauges from oxygen and fuel gas cylinders.

SAMPLE PERFORMANCE TASKS

- Look up MSDSs for designated refrigerants and compressor oils, and describe first aid procedures for accidental exposure to one or more of the substances.
- Demonstrate the proper handling and transportation of oxygen and fuel gas cylinders.
- Explain the risk of injury from electrical shock when measuring current in a compressor motor.
- Given an assignment to complete HVAC/R piping requiring soldering or brazing in a small machinery space, have students recommend procedures for supplemental ventilation.
- Given a service task on an existing HVAC/R system, use approved lockout/tagout procedure.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Applied Communications, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 6.0

Students will demonstrate proper refrigerant handling and usage as mandated by Environmental Protection Agency (EPA) Section 608 of the Clean Air Act.

LEARNING EXPECTATIONS

The student will:

- 6.1 Interpret standards as mandated by EPA Section 608 of the Clean Air Act.
- 6.2 Interpret the Clean Air Act and EPA requirements.
- 6.3 Prepare for Core, Type I and Type II technician certification of the EPA Proper Refrigerant Usage and Handling Examination.
- 6.4 Interpret Department of Transportation (DOT) regulations concerning transportation of refrigerants.

PERFORMANCE STANDARDS: EVIDENCE STANDARDS ARE MET

The student:

- 6.1.A Evaluates the process of refrigerant recovery, recycle, and reclaim.
- 6.1.B Adheres to the rules and regulations set by the Clean Air Act and EPA requirements.
- 6.2.A Researches ozone depletion.
- 6.2.B Comprehends and explains the Montreal Protocol.
- 6.2.C Demonstrates refrigerant recovery, recycle, and reclaim.
- 6.2.D Adheres to an approved disposal system.
- 6.2.E Demonstrates proper labeling and maintains correct and current records.
- 6.2.F Comprehends the procedures and importance of leak detection.
- 6.3.A Evaluates the Significant New Alternatives Policy Program (SNAP).
- 6.3.B Comprehends the benefits and necessity of technician certification.
- 6.4.A Judges the condition of a refrigerant container and determines if refrigerant container is DOT approved and whether it needs to be re-tested.
- 6.4.B Determines if recovery/recycle equipment is certified and meets requirements.

SAMPLE PERFORMANCE TASKS

- Pass an EPA 608 Refrigerant Usage and Handling Examination Core Type I and Type II.
- Dispose of empty non-refillable refrigerant cylinder.
- Use recovery equipment and prepare a refrigeration system for disposal.
- Determine whether or not a particular refrigerant recovery cylinder meets DOT approval.
- Label refrigerant cylinder with proper recovered refrigerant designation.
- Demonstrate proper method for transporting refrigerant cylinders and required by DOT.
- Document refrigerant recovered and or used via a sample task.
- Maintain a record of all refrigerant recovery, cylinder inspections, and shippings.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Applied Communications, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 7.0

Students will relate the principles of physics to the operation of heating, ventilation, air conditioning, and refrigeration systems.

LEARNING EXPECTATIONS

The student will:

- 7.1 Comprehend the concept of temperature and its measurement.
- 7.2 Analyze the concept of specific heat and heat content.
- 7.3 Examine the concept of latent heat associated with change of phase.
- 7.4 Quantify the transfer of heat due to conduction, convection, and radiation.
- 7.5 Examine the effect of pressure on the boiling point of liquids.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 7.1.A Measures temperature and temperature differences.
- 7.1.B Compares and contrasts the concepts of temperature and heat.
- 7.2.A Finds specific heat values for refrigerants and other materials in reference tables.
- 7.2.B Calculates the sensible heat needed to change the temperature of a given amount of refrigerant without a change of state.
- 7.3.A Finds heat of fusion and heat of vaporization for refrigerants and other materials in reference tables.
- 7.3.B Calculates the latent heat needed to change the phase of a given amount of refrigerant.
- 7.4.A Finds thermal conductivities/resistivities of various materials in reference tables.
- 7.4.B Calculates thermal conductivity through assemblies of different materials.
- 7.4.C Explains the transfer of heat by forced convection of air.
- 7.4.D Explains the transfer of heat by radiation.
- 7.5 Examines the relationship between applied pressure and boiling point for common refrigerants.

SAMPLE PERFORMANCE TASKS

- Monitor and graph the air temperature of an air conditioning duct over the course of several hours.
- On an operating commercial air conditioning system, measure the temperature of the refrigerant piping in a number of locations.
- Monitor and graph the temperature versus time of an ice water mixture as heat is constantly applied until the point where the water boils.
- Monitor the surface temperature of a low-wattage light bulb placed in an air duct with various airflow rates.
- Graph the boiling point versus pressure for common refrigerants.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Applied Communications, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 8.0

Students will comprehend and explain the processes involved in the basic mechanical refrigeration cycle.

LEARNING EXPECTATIONS

The student will:

- 8.1 Analyze the process associated with heat absorption in the evaporator.
- 8.2 Analyze the process associated with heat transfer by the condenser.
- 8.3 Analyze the process that occurs at the expansion device.
- 8.4 Analyze the process that occurs at the compressor.
- 8.5 Compare and contrast the properties of common refrigerants.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 8.1.A Examines the principle that the refrigerant liquid-gas mixture must be at a lower temperature than the area to be cooled (First Law of Thermodynamics).
- 8.1.B Examines how large quantities of heat are absorbed when the refrigerant undergoes a phase change (evaporation).
- 8.1.C Comprehends the principle that a low boiling point of the refrigerant is achieved by maintaining a low pressure in the evaporator.
- 8.2.A Examines the principle that the refrigerant liquid-gas mixture must be at a higher temperature than the heat sink (First Law of Thermodynamics).
- 8.2.B Examines the rejection of large quantities of heat when the refrigerant undergoes a phase change (condenses).
- 8.2.C Comprehends the temperature/pressure relationship in the condenser to achieve condensation of the refrigerant.
- 8.3.A Compares refrigerant volume increases and refrigerant pressure as it goes through the expansion device.
- 8.3.B Explains that, as a consequence of the reduced pressure, the liquid refrigerant evaporates and drops in temperature.
- 8.4.A Compares refrigerant volume and refrigerant pressure decreases and increases as the compressor compresses it.
- 8.4.B Explains that, as a consequence of the increased pressure, the temperature of the gaseous refrigerant increases.
- 8.5.A Identifies recovered refrigerants by their temperature/pressure characteristics.
- 8.5.B Compares and contrasts the environmental hazards of common refrigerants.
- 8.5.C Examines the refrigeration cycle.
- 8.5.D Explains and calculates a British Thermal Unit (BTU).

SAMPLE PERFORMANCE TASKS

- On an operating commercial refrigeration system, measure the temperature of piping entering and exiting the evaporator and the condenser, and the “high side” and “low side” pressures. Compare to the temperature/pressure charts for the specific refrigerant.
- Make a simplified sketch of a typical refrigeration unit with evaporator, compressor, condenser, and expansion valve. Label the temperatures and pressures measured in the previous task.

- Recover an unknown refrigerant and identify it by matching measured temperature and pressure with reference data.
- Verifies the saturation temperature and pressure of any given refrigerant.
- Prepare a presentation to the class, school, or community group showing examples of conduction, convection, and radiation. Enter the Tennessee SkillsUSA-VICA Job Skill Demonstration contest.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Applied Communications, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 9.0

Students will comprehend, install, and service major components in mechanical refrigeration systems.

LEARNING EXPECTATIONS

The student will:

- 9.1 Comprehend, install, and service compressors in residential and small commercial refrigeration systems.
- 9.2 Comprehend, install, and service condensers in residential and small commercial refrigeration systems.
- 9.3 Comprehend, install, and service evaporators in residential and small commercial refrigeration systems.
- 9.4 Comprehend, install, and service fixed and adjustable metering devices in residential and small commercial refrigeration systems.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 9.1.A Compares and contrasts the physical construction and operation of all common types of refrigerant compressors.
- 9.1.B Installs reciprocating, rotary vane, and scroll compressors.
- 9.1.C Inspects and services reciprocating, and scroll compressors.
- 9.2.A Compares and contrasts the physical construction and operation of air-cooled and water-cooled condensers.
- 9.2.B Installs air-cooled and water-cooled condensers.
- 9.2.C Inspects and services air-cooled and water-cooled condensers.
- 9.3.A Compares and contrasts the physical construction and operation of direct-expansion and flooded evaporators.
- 9.3.B Installs direct-expansion and flooded evaporators.
- 9.3.C Inspects and services direct-expansion and flooded evaporators.
- 9.4.A Compares and contrasts the physical construction of capillary-tube and piston-type metering devices.
- 9.4.B Compares and contrasts the construction and operation of low-side float valves, high-side float valves, automatic valves, thermostatic valves, and electronic control valves.
- 9.4.C Installs expansion valves common to residential and small commercial refrigeration systems.
- 9.4.D Inspects and services expansion valves common to residential and small commercial refrigeration systems.

SAMPLE PERFORMANCE TASKS

- Inventory the types of compressors, condensers, evaporators, and expansion valves in the refrigeration system in the school or accessible commercial building.
- For a given (physically present) five- to seven-ton commercial HVAC/R system, write detailed plans to remove and replace each major component.
- Use pressure, temperature, current, and voltage measurements to verify a compressor is operating within specifications or determine the cause for operation outside of specifications.

- On a three- to seven-ton air conditioning system, measure high- and low-side pressures, refrigerant line temperatures, condenser and evaporator input and output air temperatures, and compressor current and voltage under normal operating conditions. Re-measure these system parameters under created fault conditions, such as restricted air flows, low line voltage, undercharged refrigerant, and so on.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Applied Communications, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 10.0

Students will assemble, charge, and service refrigerant systems.

LEARNING EXPECTATIONS

The student will:

- 10.1 Assemble and test refrigeration components and piping.
- 10.2 Charge mechanical refrigeration systems.
- 10.3 Recover and recycle refrigerants.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 10.1.A Assembles and tests new piping and components in accordance with construction drawing, industry practice, applicable codes, and regulations.
- 10.1.B Repairs and tests HVAC/R piping and components in accordance with industry practice, applicable codes, and regulations.
- 10.2.A Evacuates and measures the vacuum level of refrigerant systems as specified by EPA regulations for that class system.
- 10.2.B Performs a leak test and repairs leaks.
- 10.2.C Recovers refrigerants and evacuates systems as required by EPA specifications for that class of system.
- 10.2.D Charges refrigeration systems as specified by the manufacturer or industry practice.
- 10.3.A Recycles refrigerants as specified by EPA regulations.
- 10.3.B Maintains records of ownership and custody of recovered refrigerants as specified by EPA regulations.

SAMPLE PERFORMANCE TASKS

- Assemble the new piping for a split system residential central air conditioning system, evacuate it, leak test it, and repair as required.
- Charge the above residential central air conditioning system with refrigerant and oil as specified by the manufacturer.
- Reclaim the refrigerant from the above residential central air conditioning system in accordance with EPA requirements, and disassemble the piping.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Applied Communications, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 11.0

Students will demonstrate proper use and application of various refrigerants and oils.

LEARNING EXPECTATIONS

The student will:

- 11.1 Categorize classes of refrigerants.
- 11.2 Examine the physical and chemical properties of refrigerants.
- 11.3 Categorize oils used in refrigeration and air conditioning systems.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 11.1.A Researches and compares various refrigerants.
- 11.1.B Comprehends the purpose and best use of the different types of refrigerants.
- 11.2.A Implements procedures to protect against flammable and toxic refrigerants.
- 11.2.B Charts the compatibility of various materials and refrigerants.
- 11.2.C Determines miscibility and oil return, pour point, flash point, and viscosity.
- 11.2.D Comprehend rust and oxidation inhibitors.
- 11.3. Compares the properties of oils used in refrigeration and air conditioning systems.

SAMPLE PERFORMANCE TASKS

- Draw oil samples from a refrigeration and air conditioning system.
- Demonstrate proper use of a refractometer or oil sample kit.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Applied Communications, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 12.0

Students will demonstrate communication skills required in the heating, ventilation, air conditioning, and refrigeration industry.

LEARNING EXPECTATIONS

The student will:

- 12.1 Communicate and comprehend oral and written information typically occurring in the HVAC/R industry workplace.
- 12.2 Solve problems and make decisions using a logical process.
- 12.3 Use teamwork skills to accomplish goals, solve problems, and manage conflict within groups.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 12.1.A Interprets and uses written information in common job formats, such as tables, charts, and reference materials and manuals.
- 12.1.B Interprets and uses graphical information such as blueprints, electrical schematics, process control schematics, diagrams, and other HVAC/R service and installation diagrams.
- 12.1.C Uses electronic resources to obtain service and other HVAC/R service and installation information.
- 12.1.D Analyzes information obtained from various sources to determine a diagnostic approach to HVAC/R service.
- 12.1.E Communicates clearly and appropriately in oral and written form.
- 12.1.F Interprets a HVAC/R repair order.
- 12.2.A Develops a hypothesis regarding the cause of a HVAC/R problem.
- 12.2.B Tests the hypothesis to determine the solution to the HVAC/R problem.
- 12.2.C Creates, evaluates, and revises as needed a plan to resolve a HVAC/R problem.
- 12.3.A Serves in each of the functional roles of a team.
- 12.3.B Resolves conflicts within a group.
- 12.3.C Demonstrates appropriate and positive examples of giving and accepting criticism.
- 12.3.D Modifies behavior or revises work based on appropriate criticism.
- 12.3.E Solves problems in cooperation with other members of a group.
- 12.3.F Evaluates the role of the HVAC/R service technician within the organizational system of a dealership or independent shop.

SAMPLE PERFORMANCE TASKS

- Complete an HVAC/R repair order.
- Role-play and analyze methods of conflict resolution.
- Test a potentially defective heating unit, air conditioning unit, and ventilation unit.
- Use blueprints and diagrams to execute a task.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Applied Communications, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

STANDARD 13.0

Students will demonstrate interpersonal and employability skills required in the heating, ventilation, air conditioning, and refrigeration industry.

LEARNING EXPECTATIONS

The student will:

- 13.1 Infer relationships between work ethics and organizational and personal job success.
- 13.2 Demonstrate attitudes conducive to workplace success.
- 13.3 Maintain a neat and orderly work area.
- 13.4 Assess implications of diversity for communities and workplaces.
- 13.5 Exhibit positive employability behaviors.
- 13.6 Develop individual time management and work sequencing skills.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 13.1.A Illustrates the concept of a “work ethic.”
- 13.1.B Assesses the potential impact of an individual’s work ethic on an organizational system.
- 13.1.C Infers the relationship between work ethics and personal job success.
- 13.2.A Judges which attitudes are conducive to success.
- 13.2.B Modifies behavior to reflect attitudes for success.
- 13.3.A Keeps work area organized and free from clutter.
- 13.3.B Cleans work area according to shop standard.
- 13.3.C Deduces the correlation between a clean orderly work environment and successful and efficient job performance.
- 13.4.A Points out benefits and problems that may arise from diversity in the transportation service workplace.
- 13.4.B Devises solutions to problems arising from diversity.
- 13.5.A Demonstrates proper dress for work in a transportation service facility.
- 13.5.B Demonstrates appropriate grooming for work in a transportation service facility.
- 13.6.A Assesses the benefits of incorporating time management principles into work in the transportation service industry.
- 13.6.B Displays time management and work sequencing skills in class assignments.

SAMPLE PERFORMANCE TASKS

- Explain hazards associated with improper dress.
- Research cultural diversity and equity issues impacting the transportation service industry.
- Students are divided into groups of four to six. Each group is given a different scenario of a HVAC/R service workplace situation in which an employee demonstrates a poor work ethic. The group identifies the problem and all the possible ramifications of the individual’s behavior for the organization, other employees, and the employee him/herself. Each group then presents its scenario and analysis to the class.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Applied Communications, Algebra, Geometry, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education Research (NCCER), Occupation Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, Air Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigeration and Air Conditioning Engineers, ASHRAE), Air Conditioning Contractors of America (ACCA), Occupational Safety and Health Administration (OSHA), Refrigeration Service Engineers Society (RSES)

HEATING VENTILATION AIR CONDITIONING/REFRIGERATION (HVAC/R) I

SAMPLING OF AVAILABLE RESOURCES

- National Center for Construction Education and Research (NCCER), *Core Curriculum*. Prentice Hall, Upper Saddle River, NJ; ©2000. Also known as the “Wheels of Learning” materials.
- National Center for Construction Education and Research (NCCER), *HVAC/R Level One*. Prentice Hall, Upper Saddle River, NJ; ©2001. Also known as the “Wheels of Learning” materials.
- National Center for Construction Education and Research (NCCER), *HVAC/R Level Two*. Prentice Hall, Upper Saddle River, NJ; ©1995. Also known as the “Wheels of Learning” materials.
- National Center for Construction Education and Research (NCCER), *HVAC/R Level Three*. Prentice Hall, Upper Saddle River, NJ; ©1996. Also known as the “Wheels of Learning” materials.
- National Center for Construction Education and Research (NCCER), *HVAC/R Level Four*. Prentice Hall, Upper Saddle River, NJ; ©1996. Also known as the “Wheels of Learning” materials.
- *Air Conditioning News*, BNP
- Air Conditioning Refrigeration Institute, www.ari.org
- Refrigeration Service Engineers Society (RSES), www.rses.org
- *RSES Journal*, RSES
- American Society of Heating Refrigeration and Air Conditioning Engineers, www.ashrae.org
- ACCA (Air-Conditioning Contractors Association), www.acca.org